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ABSTRACT

The Educational Testing Service studied the status of calculator use in high school classrooms. Responses were received from 4,568 high schools. Thirty-eight percent of those who were mailed a survey participated, and 12% of those who received e-mail invitations responded. Results indicate that the prevailing policy in U.S. high schools is to allow the use of calculators during classroom learning activities and tests, especially at higher levels. Scientific calculators were used more frequently than graphing calculators in algebra I and geometry, and graphing calculators were used more frequently in algebra II and precalculus and trigonometry. Teachers, however, had limited familiarity with graphing calculators with symbolic algebra capabilities. Schools indicated that there was little expertise in their use, and that policies concerning their use in the classroom were not determined. Opinions were still divided over the inclusion of a separate noncalculator section on Scholastic Assessment Test Program tests. Teachers were equally divided over requiring graphing calculators for the Mathematics Subject Tests, and only a small percentage of respondents believed that graphic calculators with symbolic algebra capabilities should be allowed for the Mathematics Subject Tests, consistent with the lack of familiarity with the calculators at the time of the survey. An appendix contains the calculator use survey. (Contains 13 tables and 9 references.) (SLD)

SAT[®] Program Calculator Use Survey

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SAT® Program Calculator Use Survey

In its 1986 position statement on "Calculators in the Mathematics Classroom," the National Council of Teachers of Mathematics (NCTM) formalized the increasing agreement among mathematics educators about the importance of using calculators throughout school curricula and programs: "The National Council of Teachers of Mathematics recommends that publishers, authors, and test writers integrate the use of the calculator into their mathematics materials at all grade levels" (NCTM, 1986).

The NCTM calculator statement also recommended that all students use calculators to

- concentrate on the problem-solving process rather than on the calculations associated with problems;
- gain access to mathematics beyond the students' level of computational skills;
- explore, develop, and reinforce concepts, including estimation, computation, approximation, and properties;
- experiment with mathematical ideas and discover patterns;
- perform those tedious computations that arise when working with real data in problem-solving situations (NCTM, 1986).

NCTM reiterated and expanded its 1986 position in a 1991 position statement on "Calculators and the Education of Youth."

In the 1989 *Curriculum and Evaluation Standards for School Mathematics* and the 2000 *Principles and Standards for School Mathematics*, NCTM continued to advocate the appropriate use of calculators in the classroom at all grade levels.

Paralleling the widespread use of calculators in schools has been the use of calculators in different testing situations. Significant changes have been introduced into wide-scale mathematics examinations, including those in the SAT® Program.

Description of the SAT Program

The College Board SAT Program includes the SAT I: Reasoning Test (SAT) and the SAT II: Subject Tests. The SAT measures verbal and mathematical reasoning abilities that students develop over time and that are related to successful performance in college. The mathematics portion of the SAT measures mathematical reasoning ability in arithmetic, algebra, and geometry in multiple-choice, quantitative comparison, and grid-in formats. Calculators have

been allowed, but not required, for this test since 1994. This policy allows any type of calculator, from basic four-function calculators to graphing calculators with symbolic algebra capabilities. Prior to 1994 this test was called the Scholastic Aptitude Test. For consistency, we will refer to the test as the SAT, regardless of the year under consideration.

The SAT II: Subject Tests are one-hour, multiple-choice achievement tests that measure subject specific knowledge and skills in 22 subjects. There are two Subject Tests in mathematics – Mathematics Level IC and Mathematics Level IIC. Both tests assume that students have taken at least three years of college-preparatory mathematics, and both measure knowledge of algebra, geometry (plane Euclidean, coordinate, three-dimensional), trigonometry, functions, probability and statistics, and miscellaneous topics. The Level IIC Test places more emphasis on trigonometry and functions, and less emphasis on algebra and geometry, than the Level IC Test does. Both Level IC and IIC require a calculator at least at the level of a scientific calculator. (Previous versions of these tests – the Mathematics Level I and Mathematics Level II Tests – did not permit the use of a calculator). Question development, field testing, and the development of prototype tests occurred from 1986 through 1990. Subsequently, the Level IIC Test was introduced in 1991, and the Level IC Test was introduced in 1995. Prior to 1994 these tests were called Achievement Tests. For consistency, we will refer to them as the Mathematics Level IC or Level IIC Tests.

Calculator Use on SAT Program Mathematics Tests

Preliminary Investigations

In parallel with the changes proposed by NCTM, the SAT Program began investigating the possibility of allowing calculators on its mathematics tests. Calculator use was introduced for the Mathematics Level IIC Test before it was permitted for the mathematics portion of the SAT.

For the SAT, a study of the effect of calculator use on performance on mathematics questions was initiated in the spring of 1989. Students who were using calculators in their mathematics classes took a test consisting of SAT mathematics questions; the students were randomly assigned to take the test either with or without a calculator. The results indicated that calculator users did slightly less well on the regular multiple-choice questions, performed almost identically with the noncalculator users on the quantitative comparison questions, and did slightly better on the new grid-in type of questions. No interaction effect between gender and calculator use was observed. This study suggested that permitting the use of calculators would have little effect upon the mean score of the test-taking population (Braswell & Jackson, 1991).

To ascertain that the introduction of calculator use on the SAT would not constitute an equity issue for students in different school settings, a survey of both urban and rural schools was conducted in the spring of 1990 (Maroney, 1990). The goal of the survey was to determine the extent to which calculators were being used in such schools by college-bound students. The survey questionnaire focused on three points related to equity issues for these students: the type of activities (e.g., homework, tests) for which calculator use was permitted, the degree to which these students had access to and made use of calculators, and the likely impact on test performance and on school policy of introducing calculator use on national tests. Over 70% of the urban and rural schools indicated that their policy permitted the use of calculators on homework and classwork for college-bound students. Over 70% of the college-bound students in urban schools and 55% of the college-bound students in rural schools were permitted to use calculators on some tests. Less than 2% of the schools did not permit calculators for college-bound students for any purpose.

Regarding student access to calculators, 55% of the urban and 65% of the rural schools reported that more than 90% of their college-bound students owned or had regular access to a calculator. Another 20% of both groups reported that 76-90% of their college-bound students had such access.

In 1990, the type of calculator thought to be most appropriate for use with the SAT was a nonprogrammable scientific calculator. Most respondents to the study (Maroney, 1990) indicated that their students would do better if calculators were permitted. The Program subsequently decided to allow almost any type of calculator for the SAT (see note to Table 1 for restrictions).

Field Trials

In spring 1992, prototype versions of a revised SAT were developed and field-tested. More than 180,000 students participated in this field trial. Results suggested that students who were permitted to use a calculator improved their scores 10 to 20 scale-score points on the 200-800 SAT scale. This was true regardless of gender or race/ethnicity. All groups of students were positively affected by the use of a calculator. Ninety-four percent indicated that they owned or had regular access to a calculator; 87% used calculators on classroom mathematics tests; 91% said calculators should be allowed on the SAT; and only 2% found the use of calculators on the test not helpful. There were only small differences in responses across different gender and racial/ethnic subgroups (College Board, 1992).

For the Subject Tests, a survey of calculator use on standardized testing was conducted in June 1991, when the Mathematics Level IIC Test was first administered. The Level IIC Test required the use of a scientific calculator to answer a subset of the questions. During this administration, test takers could

choose any of the three mathematics tests offered: Level IIC, Level II, or Level I. Calculators were not allowed on the latter two tests.

The profile of the group choosing to take the calculator-required test did not appear to differ substantially from the profile of the group choosing to take the noncalculator test, including approximately the same level of preparation and socioeconomic status. When the Mathematics Level IIC Test was introduced, students were required to choose from a list of allowed scientific calculators and were surveyed as to which calculator they used for the test. Results suggested no significant differences in test scores based on the type of scientific calculator used or the frequency of taking calculator-allowed tests. Although there were still equity concerns that needed further study, the results supported the inclusion of calculator use on the Mathematics Subject Tests (Harvey, Jackson & Faecher, 1993).

All of the information gathered from those preliminary surveys and field trials supported the premise that allowing calculators on the new tests was a reflection of what was occurring in the classrooms. Field trial data also supported the recommendation that students bring a calculator when they take the tests (Rigol, 1993).

New Calculator Policy on the SAT

In March 1994, major revisions were introduced in the SAT Program. At that time students were given the option to use calculators when they took any of the SAT Program mathematics tests. Similar changes also occurred in the Preliminary SAT/National Merit Scholarship Qualifying Tests (PSAT/NMSQT™) in October 1993. The current policy allows students to bring any four-function (PSAT/NMSQT and SAT only), scientific, or graphing calculator that meets College Board hardware guidelines. They are not permitted to use devices with QWERTY keypads, hand-held minicomputers, pen-input devices, pocket organizers, laptop computers, or calculators that have paper tape or require an electrical outlet. Table 1 summarizes the history of calculator use on the PSAT/NMSQT, SAT, and Mathematics Subject Tests.

Purpose of the Current Study

Although the SAT Program has allowed the use of calculators for several years, the practical issues involved are ongoing. Technology is changing rapidly, and a variety of powerful calculators are currently available, such as graphing calculators with symbolic algebra capabilities. The symbolic algebra capability allows users to perform algebraic manipulations such as solving equations for unknown values and factoring or expanding algebraic expressions. These capabilities may have an impact on the difficulty of some items on SAT Program tests.

Table 1
Use of Calculators on the PSAT/NMSQT, SAT, and Mathematics Subject Tests

June 1991	Mathematics Level IIC Achievement Test (now SAT II: Mathematics Level IIC Subject Test) introduced; scientific (nongraphing) calculators were required for this optional version of the Mathematics Level II Test offered on selected test dates.
October 1993	Calculators permitted, but not required, on PSAT/NMSQT.
January 1994	Last administration of Mathematics Level II Subject Test (only Mathematics Level IIC would be offered at future administrations).
March 1994	Calculators permitted, but not required, on SAT.
May 1994	Mathematics Level IIC Subject Test requires calculators at least at the level of a scientific calculator, and graphing calculators are permitted.
June 1995	Mathematics Level IC Subject Test introduced; calculators at least at the level of a scientific calculator are required, and graphing calculators are permitted, for this optional calculator-required version of the Mathematics Level I test offered on selected test dates.
January 1998	Last administration of Mathematics Level I Subject Test (only Mathematics Level IC will be offered at future administrations).
October 2000	Calculator requirement for Mathematics Level IC and Level IIC Subject Tests is revised. A scientific or graphing calculator is required. A graphing calculator may provide an advantage over a scientific calculator on some questions. The tests are developed with the expectation that most students are using graphing calculators.

Note: The College Board calculator policy allows four-function, scientific, or graphing calculators, including those with symbolic algebra capabilities, unless otherwise specified. College Board policy does not allow minicomputers, electronic writing pads or pen-input devices, pocket organizers, or devices with QWERTY keyboards, paper tapes, sound, or those requiring an electrical outlet. Up-to-date information on College Board calculator policies for mathematics and science is available online at www.collegeboard.org.

To keep up with advances in calculator capabilities, it is important to reexamine the use of calculators in high schools and possibly revise policies for the SAT Program that reflect that use. To accomplish this, in spring 1999, ETS undertook a calculator use survey on behalf of the College Board to investigate the current status of calculator use in classrooms and schools. The primary purposes of this calculator use survey were to

- describe the types of calculators required or allowed in classrooms;
- quantify the expected use of the new graphing calculators with symbolic algebra capabilities;
- identify potential contacts for focus group meetings on in-depth topics;
- measure the attitudes of high school teachers toward potential policy changes regarding calculators.

Specifically, the survey was expected to answer the following research questions:

- How experienced are teachers with the use of graphing calculators and with graphing calculators with symbolic algebra capabilities?
- Are calculators an integral part of the high school mathematics curriculum?
- Are there particular profiles of calculator use in the schools?
- What are the most common types of calculators used?
- What types of calculators are permitted in the classroom?
- Are calculators allowed for testing in the classroom?
- What are the plans for the use of graphing calculators with symbolic algebra capabilities in the classroom in the near future?
- Should there be separate noncalculator sections on the SAT Program mathematics tests?
- Should graphing calculators be required for some questions on the Mathematics Subject Tests?

Methodology

Participants

Participants in the survey were chosen from the 31,717 accredited secondary instructional programs on the SAT Program master files, including public and private high schools, charter schools, and home school associations. These are referred to as "attending institutions." Some familiarity with SAT Program tests was needed to answer some of the survey questions, so schools with more than 10 SAT mathematics test takers were selected to receive a questionnaire, resulting in a sample of 11,776 schools. Surveys were mailed to mathematics department heads in those schools in April 1999. In addition, 252 mathematics teachers in 26 states were sent e-mail requests to participate in the survey. All of the teachers were given the option of completing the paper survey or completing the survey via the Internet.²

Questionnaire

The survey questionnaire asked mathematics departments to indicate, for algebra 1, algebra 2, geometry, and precalculus courses, whether or not calculators are allowed or required in classroom demonstrations, homework, or on classroom tests, as well as the types of calculators allowed or required. In addition, teachers were asked to indicate their levels of experience with graphing calculators, and with graphing calculators with symbolic algebra capabilities. Teachers were also asked what their school's policy will be regarding the use of

² The e-mail invitations and the Internet version of the survey were attempted as an experiment in recruiting survey participation in a more cost-effective mode.

graphing calculators with symbolic algebra capabilities, whether or not they believe SAT Program tests should have a separate noncalculator section, and if they believe graphing calculators should be required for the Mathematics Subject Tests. The questionnaire is presented in the appendix.

Results and Discussion

Samples

The return rate was moderate (39%), with responses from 4,568 schools. Thirty-eight percent of those who were mailed a survey participated, and 12% of those who received e-mail invitations participated.

Because of the criterion of more than 10 SAT test takers from an attending institution, this sample cannot be considered to be nationally representative. When survey respondents were compared with the SAT Program master files, the following differences were found:

College Board Region. The middle states were overrepresented (23% vs 13%), while the Midwest was underrepresented (17% vs 26%). The sample also included 151 foreign schools. Table 2 gives the number of schools responding from each region.

Table 2
Number of Surveys Returned, by College Board Region

	Region							Total
	New England	Middle States	South	South-west	Mid-west	West	Foreign	
Total Survey Respondents	396 (9%)	1027 (23%)	928 (20%)	385 (8%)	774 (17%)	878 (19%)	151 (3%)	4539 (14%)
Total Attending Institutions	1416 (4%)	4026 (13%)	6369 (20%)	3378 (11%)	8104 (26%)	5349 (17%)	3044 (10%)	31686

Notes:

- Frequency missing = 29 for region.
- Percents are percent of the number in the "Total" column.
- "Total Survey Respondents" is the total number of surveys with responses to the questions in the table; "Total Attending Institutions" is the total number of schools on the SAT Program master file who provided the relevant information.

School Type. Public institutions were overrepresented (74% vs 64%), while other religious institutions (not Catholic) were underrepresented (7% vs 19%). Table 3 gives the number of schools responding from each school type.

Table 3
Number of Surveys Returned, by School Type

	School Type					Total
	Public	Independent, Nonreligious	Independent Catholic	Independent Other Religious	Other	
Total Survey Respondents	3367 (74%)	418 (9%)	425 (9%)	321 (7%)	8 ($<1\%$)	4539
Total Attending Institutions	19770 (64%)	3123 (10%)	1639 (5%)	5963 (19%)	382 (1%)	30877

Notes:

- Frequency missing = 29 for school type.
- Percents are percent of the number in the "Total" column.
- "Total Survey Respondents" is the total number of surveys with responses to the questions in the table; "Total Attending Institutions" is the total number of schools on the SAT Program master file who provided the relevant information.

School Location. Suburban institutions were overrepresented (27% vs 15%), while rural institutions were underrepresented (18% vs 28%). Table 4 gives the number of schools responding from each school location.

Table 4
Number of Surveys Returned, by School Location

	School Location					Total
	Large City	Medium City	Small City	Suburban	Rural	
Total Survey Respondents	826 (18%)	624 (14%)	1035 (23%)	1207 (27%)	829 (18%)	4521
Total Attending Institutions	4730 (17%)	3326 (12%)	7683 (28%)	4041 (15%)	7686 (28%)	27466

Notes:

- Frequency missing = 47 for school location.
- Percents are percent of the number in the "Total" column.
- "Total Survey Respondents" is the total number of surveys with responses to the questions in the table; "Total Attending Institutions" is the total number of schools on the SAT Program master file who provided the relevant information.

School Size. Very large and large institutions were overrepresented (79% vs 42%), while small institutions were underrepresented (4% vs 36%). Table 5 gives the number of respondents from schools of very small to very large size.

Table 5
Number of Surveys Returned, by School Size

	School Size				Total
	Very Large	Large	Medium	Small	
Total Survey Respondents	2192 (48%)	1421 (31%)	760 (17%)	166 (4%)	4539
Total Attending Institutions	6791 (21%)	6789 (21%)	6772 (21%)	11365 (36%)	31717

Notes:

- Frequency missing = 29 for school size.
- Percents are percent of the number in the "Total" column.
- "Total Survey Respondents" is the total number of surveys with responses to the questions in the table; "Total Attending Institutions" is the total number of schools on the SAT Program master file who provided the relevant information.
- Definition of "School Size":
 Very Large = The number of students in grades 9-12 is greater than 826.
 Large = The number of students in grades 9-12 is less than or equal to 826 but greater than 306.
 Medium = The number of students in grades 9-12 is less than or equal to 306 but greater than 95.
 Small = The number of students in grades 9-12 is less than or equal to 95.

Research Question 1: How experienced are teachers with the use of graphing calculators and with graphing calculators with symbolic algebra capabilities?

Survey question 3 asked about levels of experience of teachers with regard to the capabilities of graphing calculators, with the choices being Beginner, Intermediate, or Advanced. Each school was then categorized at a high, medium-high, medium-low, or low experience level based on the percent of teachers in each category. If a school is in a higher category, it is not considered for a lower category.

A school was categorized as high if

- at least 50 percent of the teachers are Intermediate or Advanced, and
- at least 20 percent are Advanced.

A school was categorized as medium-high if

- at least 50 percent of the teachers are Intermediate or Advanced and less than 20 percent are Advanced; or
- at least 25 percent are Intermediate and some are Advanced; or
- at least 20 percent are Advanced.

A school was categorized as low if

- less than 20 percent of the teachers are Intermediate, and
- no teachers are Advanced.

All others were considered medium-low.

Fifty-three percent of the schools fell in the high category, and 20% fell in the medium-high category.

Survey question 6, dealing with teachers' experiences with graphing calculators that have symbolic algebra capabilities, drew a quite different response. Only 25% of schools fell in the high or medium-high category. At the time of the survey, availability of these calculators was still fairly limited. It is important to note that a survey even a few months later may have made a large difference in these figures. Nevertheless, the contrast between experience with graphing calculators and experience with graphing calculators that have symbolic algebra capabilities is striking.

Table 6 presents information on teachers' experience with graphing calculators and with graphing calculators with symbolic algebra capabilities.

Table 6
Teachers' Experiences with Graphing Calculators and with Graphing Calculators with Symbolic Algebra Capabilities

Experience Level	Graphing Calculators	Graphing Calculators with Symbolic Capabilities
High	2265 (53%)	312 (7%)
Medium-High	854 (20%)	752 (18%)
Medium-Low	1065 (25%)	1333 (31%)
Low	125 (3%)	1870 (44%)
Total	4309	4267

Notes:

- Frequency missing for graphing calculators = 259; frequency missing for graphing calculators with symbolic capabilities = 301.
- Percents are percent of the number in the "Total" row.

Research Question 2: Are calculators an integral part of the high school mathematics curriculum?

As was documented earlier, mathematics educators widely agree that calculators should be integrated into school curricula and programs. The evidence from previous studies indicated that calculators are being used throughout the curriculum (College Board, 1992; Maroney, 1990). Consistent with previous research, results from this survey also supported this general tenet (Tables 7a-7c).

In response to survey question 4, which asked about the prevailing departmental calculator policy, 99.9% of schools indicated that they either require or allow calculators for some part of their college preparatory math sequence. Among those schools, 95% either require or allow calculators in algebra I; 98% either require or allow calculators in geometry; 99% either require or allow calculators in algebra II; and 99.9% either require or allow calculators in precalculus/trig (Table 7a). In contrast to Maroney's 1990 survey, which found that approximately 70% of the urban and rural schools permitted the use of calculators, the results of this survey showed that virtually all schools are implementing calculator use as an integral part of the mathematics curriculum.

Are scientific calculators an integral part of the mathematics curriculum?

More specifically, survey question 4 asked about the prevailing calculator policy regarding scientific calculators and graphing calculators, respectively. More than one-third of the respondents reported that they require scientific calculators regardless of the course level (30%-34%). Compared with graphing calculators, scientific calculators are more frequently required in algebra I (30% vs 18%) and geometry (33% vs 12%) for classroom learning activities and homework (see Tables 7b and 7c).

Are graphing calculators an integral part of the mathematics curriculum?

In response to the question regarding graphing calculator use, it appears that the percentage of schools requiring a graphing calculator increases rapidly with course level: algebra I (18%), geometry (12%), algebra II (42%), and precalculus/trig (70%). It also appears that graphing calculators are an integral part of algebra II and precalculus/trig classrooms, with 42% and 70% of schools, respectively, requiring this type of calculator (see Table 7c).

Table 7a
Prevailing Calculator Policy in High School Mathematics Departments –
Either Scientific or Graphing Calculators

Course	Either			Total
	Required	Allowed	Not Allowed	
Algebra I or Course I of a college preparatory math sequence	2067 (46%)	2210 (49%)	190 (4%)	4467
Geometry or Course II of a college preparatory math sequence	1973 (44%)	2459 (55%)	68 (2%)	4500
Algebra II or Course III of a college preparatory math sequence	3046 (67%)	1447 (32%)	29 (1%)	4522
Precalculus/trig or Course IV of a college preparatory math sequence	3747 (83%)	765 (17%)	4 (<1%)	4516

Notes:

- Frequency missing = 101 for algebra I, 69 for geometry, 46 for algebra II, and 52 for precalculus/trig.
- Each respondent is potentially counted three times: once for "Scientific," once for "Graphing," and once for "Either."
- Percents are percent of the number in the "Total" column.
- Definitions for the "Either" column:
 Required = Either "Scientific" or "Graphing" was selected as "Required."
 Allowed = Either "Scientific" or "Graphing" was selected as "Allowed," but neither was selected as "Required."
 Not Allowed = Both "Scientific" and "Graphing" were selected as "Not Allowed."
- Summation of percents may exceed 100% because of rounding.

Table 7b
Prevailing Calculator Policy in High School Mathematics Departments –
Scientific Calculators

Course	Scientific			Total
	Required	Allowed	Not Allowed	
Algebra I or Course I of a college preparatory math sequence	1357 (30%)	2267 (51%)	243 (5%)	4467
Geometry or Course II of a college preparatory math sequence	1507 (33%)	2322 (52%)	87 (2%)	4500
Algebra II or Course III of a college preparatory math sequence	1521 (34%)	1825 (40%)	76 (2%)	4522
Precalculus/trig or Course IV of a college preparatory math sequence	1339 (30%)	1484 (33%)	93 (2%)	4516

Notes:

- Frequency missing = 101 for algebra I, 69 for geometry, 46 for algebra II, and 52 for precalculus/trig.
- Percents are percent of the number in the "Total" column.

Table 7c
Prevailing Calculator Policy in High School Mathematics Departments –
Graphing Calculators

Course	Graphing			Total
	Required	Allowed	Not Allowed	
Algebra I or Course I of a college preparatory math sequence	819 (18%)	2463 (55%)	560 (13%)	4467
Geometry or Course II of a college preparatory math sequence	537 (12%)	2922 (65%)	372 (8%)	4500
Algebra II or Course III of a college preparatory math sequence	1880 (42%)	2050 (45%)	241 (5%)	4522
Precalculus/trig or Course IV of a college preparatory math sequence	3160 (70%)	1212 (27%)	43 (1%)	4516

Notes:

- Frequency missing = 101 for algebra I, 69 for geometry, 46 for algebra II, and 52 for precalculus/trig.
- Percents are percent of the number in the "Total" column.

Research Question 3: *Are there particular profiles of calculator use in the schools?*

The results of survey question 4 were further analyzed in an effort to discover profiles of calculator use in the schools. In other words, do schools have similar calculator policies across their mathematics courses? When looking across all four courses and both calculator types, no large numbers of schools with similar response patterns could be identified. Instead, six profiles were identified as plausible for algebra II and precalculus/trig, which are typical courses for college-bound students. Table 8 summarizes these six profiles.

Profile 1 is the most common. This profile, which includes 1,839 schools (41%), requires graphing calculators for both algebra II and precalculus/trig. The second largest pattern occurs at the 1,510 schools (34%) that either allow or require any calculator for both algebra II and precalculus/trig. The third most common profile, which allows graphing calculators for algebra II while requiring graphing calculators for precalculus/trig, occurs at 997 schools (22%). Profile 3, which allows or requires scientific calculators but does not allow graphing calculators, for both algebra II and precalculus/Trig, occurs at 123 schools (3%). The least common profiles are profile 4 and profile 6, with less than 1% of schools in these two profiles combined. Profile 4 does not allow calculators for either algebra II or precalculus/trig. Profile 6 does not allow graphing calculators for algebra II, but allows or requires them for precalculus/trig.

Table 8
Profiles of Calculator Use in the Schools

Profile	Algebra II	Precalculus/Trig	Total (%)
1	Require graphing calculator	Require graphic calculator	1,839 (41%)
2	Allow graphing calculator	Require graphing calculator	997 (22%)
3	Allow or require scientific calculator; Do not allow graphing calculator	Allow or require scientific calculator; Do not allow graphing calculator	123 (3%)
4	Do not allow any calculators	Do not allow any calculators	5 (<1%)
5	Either allow or require any calculator	Either allow or require any calculator	1,510 (34%)
6	Do not allow graphing calculator	Allow or require graphing calculator	22 (<1%)

Notes:

- Frequency missing = 72. Each respondent was counted once, with the order listed in the table as the order of inclusion. For example, a respondent who fit the profile "Require graphing calculator for algebra II and precalculus/trig" would not be counted in the profile "Either allow or require any calculator for both algebra II and precalculus/trig."
- Percents are percent of the 4496 respondents who fit any one of the six profiles.

Research Question 4: What are the most common types of calculators used?

Survey question 5 asked about the types of calculators used by most students. The results indicated that scientific calculators are the most popular for algebra I and geometry, although a large percentage of teachers indicated that their students use no particular calculator. For algebra II and precalculus/trig, graphing calculators are the most popular.

Research Question 5: What types of calculators are permitted in the classroom?

In response to survey question 7, "Check all calculator types that students in your department are currently permitted to use," about 50% of respondents indicated that any calculator is permitted for algebra I, geometry, and algebra II. For precalculus/trig, graphing calculators are most likely to be permitted (49%). Graphing calculators with symbolic algebra capabilities are least likely to be permitted (1-4%). Table 9 presents information on permitted calculator types.

Table 9
Calculator Types that Students Are Currently Permitted to Use

Course	Scientific	Graphing Casio 9700, Casio 9800, Casio 9850, Sharp 9200, Sharp 9300, Sharp 9600, TI-82, TI-83 TI-85, or TI-86	Graphing with Symbolic Algebra Capabilities Casio 9970, HP 38G, HP 48 Series, or TI-89	Other Graphing Calculators Casio 7700, TI-81, etc.	Any Calculator Is Allowed	Number Responding
Algebra I or Course I	1662 (39%)	1418 (33%)	37 (1%)	597 (14%)	2014 (47%)	4245
Geometry or Course II	1664 (38%)	1436 (33%)	58 (1%)	547 (13%)	2160 (50%)	4359
Algebra II or Course III	1448 (33%)	1896 (43%)	88 (2%)	628 (14%)	2035 (46%)	4431
Precalculus/trig or Course IV	1042 (23%)	2196 (49%)	193 (4%)	646 (14%)	2061 (46%)	4463

Research Question 6: Are calculators allowed for testing in the classroom?

In response to survey question 10 – “How often are students permitted to use scientific calculators or graphing calculators on classroom tests?” – 40% to 52% of schools always allow scientific calculators for tests. The percentage who always allow graphing calculators increases with class level: algebra I (22%), geometry (26%), algebra II (37%), and precalculus/trig (54%).

In Maroney's 1990 survey, the response was more conservative in the area of testing: only 25.9% of schools allowed students to use calculators for classroom tests.

Only a small number of schools never allow calculators for tests: 5% for algebra I, 2% for geometry, 1% for algebra II, and less than 1% for precalculus/trig (see Table 10 notes). Table 10 presents the results on the use of calculators for classroom testing.

Table 10
Calculators Allowed for Use on Classroom Tests

Course	Scientific			Graphing			Total Responding
	Never	Some tests or portions of tests	Always	Never	Some tests or portions of tests	Always	
Algebra I or Course I	282 (6%)	1714 (39%)	1777 (40%)	845 (19%)	1688 (39%)	947 (22%)	4390
Geometry or Course II	123 (3%)	1423 (32%)	2276 (52%)	778 (18%)	1506 (34%)	1165 (26%)	4416
Algebra II or Course III	91 (2%)	1079 (24%)	2222 (49%)	346 (8%)	1978 (44%)	1680 (37%)	4489
Precalculus/trig or Course IV	120 (3%)	754 (17%)	2150 (48%)	98 (2%)	1831 (41%)	2442 (54%)	4484

Notes:

- Frequency missing = 178 for algebra I, 152 for geometry, 79 for algebra II, and 84 for precalculus/trig.
- Percents are percent of the number in the "Total Responding" column. Each respondent was counted up to two times, once for "Scientific" and once for "Graphing."
- The number of schools that never allow calculators for tests refers to schools neither allow scientific calculators nor allow graphing calculators.

Research Question 7: *What are the plans for the use of graphing calculators with symbolic algebra capabilities in the classroom in the near future?*

For survey question 11, which asked about future plans for the use of graphing calculators with symbolic algebra capabilities, 72% of schools responded that they have not yet determined their policy. Of those who have, there is no one policy that stands out as a popular choice: 8% will not allow the calculators, while 6% will allow the calculators from algebra I on. Table 11 summarizes the use of graphing calculators with symbolic algebra capabilities.

Table 11
Policy Regarding the Use of Calculators with Symbolic Capabilities

School Policy	Total
We have not yet determined our policy.	3233 (72%)
We will not allow these calculators.	344 (8%)
We will allow these calculators for most courses from Algebra I on.	270 (6%)
We will allow these calculators for most courses, but we will restrict their use, such as not allowing use on tests.	333 (7%)
We will allow these calculators in selected courses, but not others.	293 (7%)
Total	4473

Notes:

- Frequency missing = 95.
- Percents are percent of the number in the "Total" column.

Research Question 8: Should there be separate noncalculator sections on the SAT Program mathematics tests?

Survey question 12 asked teachers' opinions regarding whether there should be some questions for the PSAT/NMSQT, SAT, and Mathematics Level IC and IIC Tests that do not allow the use of calculators. A slightly higher percent indicated "yes" for the PSAT/NMSQT (59% vs 41%) and the SAT (56% vs 44%). Approximately equal numbers chose "yes" and "no" for the Mathematics Subject Tests. Table 12 summarizes the respondents' opinions.

Table 12
Should There Be a Separate Noncalculator Section?

Test	Yes, there should be a separate non-calculator section	No, there should not be a separate noncalculator section	Total Responding "Yes" or "No"
PSAT/NMSQT	2510 (59%)	1756 (41%)	4266
SAT	2358 (56%)	1823 (44%)	4181
Mathematics Level IC Test	2054 (52%)	1920 (48%)	3974
Mathematics Level IIC Test	1963 (50%)	1974 (50%)	3937

Notes:

- The survey respondents were given a third choice: "We are not familiar with this test." Those choosing this response were counted as missing. The frequency missing = 302 for PSAT/NMSQT, 387 for the SAT, 594 for Mathematics Level IC, and 632 for Mathematics Level IIC.
- Percents are percent of the number in the "Total Responding Yes or No" column.

Research Question 9: Should graphing calculators be required for some questions on the SAT II: Mathematics Subject Tests?

In response to survey question 13 – "Do most teachers in your department think graphing calculators should be required for some of the questions on the SAT II: Mathematics Subject Tests?" – approximately 50% of the schools said graphing calculators should be required. Only a small percent (9% for IC and 10% for IIC) felt that calculators with symbolic algebra capabilities should be allowed (Table 13).

Table 13
Graphing Calculator Use in the Mathematics Subject Tests

Test	No, do not require graphing calculators but continue to permit their use	Yes, require graphing calculators, but do not allow those with symbolic capabilities	Yes, require graphing calculators, and allow even those with symbolic capabilities	Total Responding
Mathematics Level IC	2266 (53%)	1587 (37%)	397 (9%)	4250
Mathematics Level IIC	2104 (50%)	1706 (40%)	434 (10%)	4244

Notes:

- Frequency missing = 318 for Mathematics Level IC and 324 for Mathematics Level IIC.
- Percents are percent of the number in the "Total Responding" column.

Summary

This survey indicates that the prevailing policy in United States high schools is to allow the use of calculators during classroom learning activities and tests. Particularly at the higher levels – algebra II and precalculus/trig – calculators are being used for teaching, homework, and testing in virtually every school. Scientific calculators are more frequently used than graphing calculators in algebra I and geometry, whereas graphing calculators are more frequently used in algebra II and precalculus/trig.

Although graphing calculators have become commonplace in many schools, at the time of this survey teachers had limited familiarity with graphing calculators with symbolic algebra capabilities. Schools indicated that there was little expertise in their use, and that policies regarding their use in the classroom were not determined.

In contrast to the pervasive use of calculators in the classroom, opinions are still divided over the inclusion of a separate, noncalculator section on SAT Program tests. This appears to reflect how teachers test in the classroom, with a moderate percentage of schools reporting that they do not allow calculators for some portion of their tests.

Teachers were equally divided over requiring graphing calculators for the Mathematics Subject Tests. This is also reflective of their use in the classroom, with only 42% *requiring* graphing calculators in algebra II. However, 70% of the schools indicated that graphing calculators are required for the precalculus/trig course. Since the content of this course is expected for the Mathematics Level IIC Test, the percentage of respondents indicating that a graphing calculator

should be required for the Mathematics Level IIC Test would be expected to be higher.

Only a small percentage of respondents believe that graphing calculators with symbolic algebra capabilities should be allowed for the Mathematics Subject Tests, consistent with the lack of familiarity with the calculators at the time of the survey.

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APPENDIX

Calculator Use Survey

The SAT Program is committed to a calculator use policy that reflects good classroom practice. To assist in formulating that policy, please answer the following questions for your department. If the policies of individual teachers within the department vary, answer with the **prevailing** practice for college preparatory mathematics courses through precalculus/ trigonometry.

1. What is your position? (Check one.)

___ Math dept. head (nonteaching) ___ Math dept. head (teaching) ___ Math teacher

2. How many teachers are there in your mathematics department? ____

3. What is the level of experience of teachers in your department with regard to the capabilities of graphing calculator technology? (Indicate the number of teachers in each category.)

___ Beginner ___ Intermediate ___ Advanced

4. For the courses listed below, what is the prevailing calculator policy in your department? (For each course, check only one box under "Scientific" and one box under "Graphing.")

	Scientific			Graphing		
	Required	Allowed	Not Allowed	Required	Allowed	Not Allowed
Algebra I or Course I of a college preparatory math sequence						
Geometry or Course II of a college preparatory math sequence						
Algebra II or Course III of a college preparatory math sequence						
Precalculus/Trig or Course IV of a college preparatory math sequence						

If you answered "Not Allowed" for all the courses in question 4, please go to question 11.

5. List the manufacturer and model number of the one or two calculators used by most students in your department.

	Manufacturer/Model No. (Casio 9850, HP 48 series, Sharp 9600, TI-83, etc.)	No particular calculator is used by our students.
Algebra I or Course I		
Geometry or Course II		
Algebra II or Course III		
Precalculus/Trig or Course IV		

6. How familiar are teachers in your department with graphing calculators that have symbolic algebra capabilities, such as Casio 9970, HP 48 series, or TI-89? (Indicate the number of teachers in each category.)

_____ Not familiar at all _____ Somewhat familiar _____ Very familiar

7. For the courses listed below, check all calculator types that students in your department are currently permitted to use.

	Scientific	Graphing Casio 9700, Casio 9800, Casio 9850, Sharp 9200, Sharp 9300, Sharp 9600, TI-82, TI-83, TI-85, or TI-86	Graphing with Symbolic Algebra Capabilities Casio 9970, HP 38G, HP 48 Series, or TI-89	Other Graphing Calculators Casio 7700, TI-81, etc.	Any calculator is allowed.
Algebra I or Course I					
Geometry or Course II					
Algebra II or Course III					
Precalculus/Trig or Course IV					

8. For the courses listed below, how often do students use a scientific or graphing calculator in the classroom for learning activities?

	Scientific				Graphing			
	Never	Occasionally	Frequently	Nearly Always	Never	Occasionally	Frequently	Nearly Always
Algebra I or Course I								
Geometry or Course II								
Algebra II or Course III								
Precalculus/Trig or Course IV								

9. For the courses listed below, how often are students **expected** to use a scientific or graphing calculator on homework or other assignments outside of class?

	Scientific				Graphing			
	Never	Occasionally	Frequently	Nearly Always	Never	Occasionally	Frequently	Nearly Always
Algebra I or Course I								
Geometry or Course II								
Algebra II or Course III								
Precalculus/Trig or Course IV								

10. For the courses listed below, how often are students permitted to use scientific or graphing calculators on classroom tests?

	Scientific			Graphing		
	Never	Some tests or portions of tests	Always	Never	Some tests or portions of tests	Always
Algebra I or Course I						
Geometry or Course II						
Algebra II or Course III						
Precalculus/Trig or Course IV						

11. *The use of calculators on examinations creates some tension related to what students can do on their own and what calculators can do for them. To assist in planning for future test editions, please answer the following.*

What will your school's policy be in the near future regarding the use of calculators with symbolic capabilities, such as the Casio 9970 or TI-89? (Check only one.)

☐	We have not yet determined our policy.
☐	We will not allow these calculators.
☐	We will allow these calculators for most courses from Algebra I on.
☐	We will allow these calculators for most courses, but we will restrict their use, such as not allowing use on tests.
☐	We will allow these calculators in selected courses, but not others. (List the courses for which they will be allowed: _____)

12. For each of the following tests, do most teachers in your department believe there should be some questions that do **not** allow the use of calculators? (Check one for each test.)

	Yes, there should be a separate non-calculator section	No, there should not be a separate non-calculator section	We are not familiar with this test
PSAT/NMSQT			
SAT I: Reasoning Test			
SAT II: Mathematics Level IC			
SAT II: Mathematics Level IIC			

13. For the SAT II: Mathematics Level IC and IIC Subject Tests, a scientific calculator is the minimum requirement; graphing calculators are permitted. Some thought is being given to requiring graphing calculators.

Do most teachers in your department think graphing calculators should be required for some of the questions on the SAT II: Mathematics Subject Tests?

	No, do not require graphing calculators	Yes, but do not allow graphing calculators with symbolic capabilities	Yes, require graphing calculators, and allow even those with symbolic capabilities
SAT II: Mathematics Level IC			
SAT II: Mathematics Level IIC			

Why or why not?

14. Are there other comments you would like to share with the College Board about the use of calculators on mathematics tests? (Feel free to attach comments on a separate sheet.)

15. Would you be willing to receive a follow-up phone call on some of the issues covered in this survey? (All survey results will remain confidential.)

If yes: Name _____ School _____

Telephone (____) _____ - _____ Best Time to Call _____

E-mail address _____

Please return your survey in the enclosed business reply envelope by **April 30, 1999**, to:

Anita O'Brien, Mailstop 04-L, Educational Testing Service, Princeton, NJ 08548-0001